Report from the Breckenridge, Colorado Magnetic Storm/Substorm workshop June 24-27, 1993

Are magnetic storms qualitatively different than magnetospheric substorms? Is a storm simply the summation of several substorms? Are the magnetospheric processes that cause a substorm fundamentally different from those that cause a storm? The National Geophysical Data Center and the Space Environment Laboratory hosted a workshop to discuss these questions and to investigate the relationship between magnetic storms and magnetospheric substorms.

Magnetic storms have not received the same amount of attention as substorms for the last several years due to a number of' factors: there has been a stronger emphasis toward the "simpler" substorm phenomenology, the complexity of storm phenomena has deterred analysis, and the lack of appropriate data and incomplete data coverage in space and time has made analysis difficult. continuing an effort begun at San Jose dos Campos, Brazil on November 5 - 7, 1991, twelve scientists went to the mountain to seek the answer, *or*, at least, to ask the pertinent questions. Each brought experience on different pieces of the puzzle; the solar wind, magnetospheric and ionospheric plasmas and fields, and geomagnetic variations.

At the first workshop, a magnetic storm was defined as "an interval of intensified ring current which exceeds some key threshold of the quantifying storm-time Dst index. The cause is a sufficiently intense and long-lasting, interplanetary electric field which leads to substantial energization of the magnetosphere-ionosphere system. ''[Gonzalez et al., 1993].

Magnetospheric substorms [Rostoker et al., 1980;1987] have been defined as " . ..an interval of increased energy dissipation confined, for the most part, to the *region* of the auroral oval. The onset of this process is signaled by explosive increases in auroral luminosity in the midnight sector, and the entire process encompasses an interval during which the strength of the current in the auroral electrojets increases from and returns to the background level from which the substorm arose."

Noting that a greatly enlarged polar cap area precedes substorms associated with a magnetic storm and that frequent substorms progressively heat the plasma sheet, we developed "a workshop scenario of magnetic storms" as follows:

A. Enhanced solar wind electric fields of sufficient duration directly drive magnetospheric convection which, in turn, enhances the ring currents and drives auroral ionospheric current systems.

B. The explosive part of the first substorm occurring within the main phase of the storm primes the magnetosphere-ionosphere system by heating plasma sheet and ionospheric plasma.

C. Subsequent substorms occurring in rapid succession continue to energize preheated magnetospheric and ionospheric particles resulting in further enhancement of the storm-time currents. This is the main phase of the magnetic storm when the equatorward boundary of the auroral oval marches equatorward.

D. As integrated solar wind electric fields diminish, the inner edge of the plasma sheet retreats tailward making subsequent substorms less effective toward ring current intensifications. This is the recovery phase of the magnetic storm when the equatorward boundary retreats poleward.

These elements appear in Figure 1 in that Dst begins decreasing shortly after Bz turns southward. Intense substorms occur and recur until the storm-causing Bz turns northward. At about this time Dst reaches a peak negative value. Then Dst begins to recover and subsequent substorms occur less frequently and no longer appreciably decrease Dst. The Workshop participants defined a procedure to collect the appropriate data to refine and test this scenario and work is in progress.

Workshop organizers were H. Kroehl, W. Gonzalez and J. Joselyn. Attendees, in addition to the organizers, were W. Baumjohann, N. Crooker, Y. Kamide, J. Phillips, G. Rostoker, H. Singer, G. Siscoe, B. Tsurutani and V. Vasyliunas.

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